Modeling meso-scale electric field variability through GCMs

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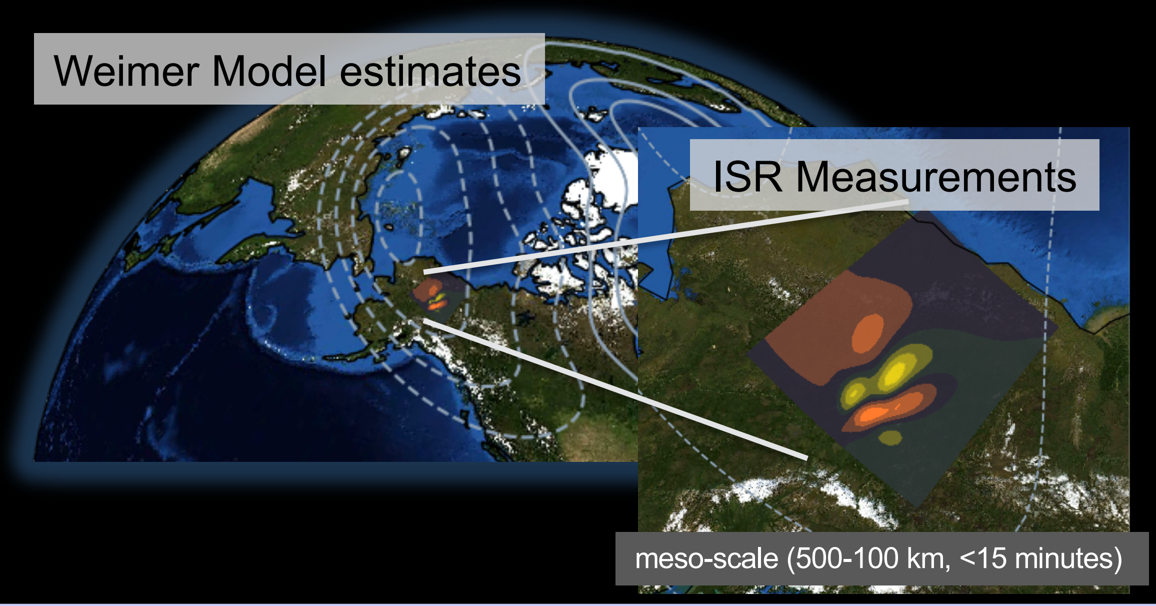

- Global Circulation Models (GCMs) traditionally use empirical models for global estimates of **electric fields and conductivity** and significant work is ongoing to resolve meso-scale structures[1].
- Missing meso-scale electric field variability (temporal + spatial) causes **underestimation of energy input and dissipation in the high-latitude Ionosphere**[2].

1 Codrescu et al. 1995; Deng et al. (2009); Cousins et al. (2013)
2 Cosgrove et al. (2009); Huang et al. (2014); Brinkman et al. (2016)

Our aim is to understand **the role of meso-scale electric fields in energy dissipation at high-latitude I-T system**. This talk summarizes our efforts in quantifying dynamic driving using ISR measurements and adapting a first-principles model to dynamical driving.

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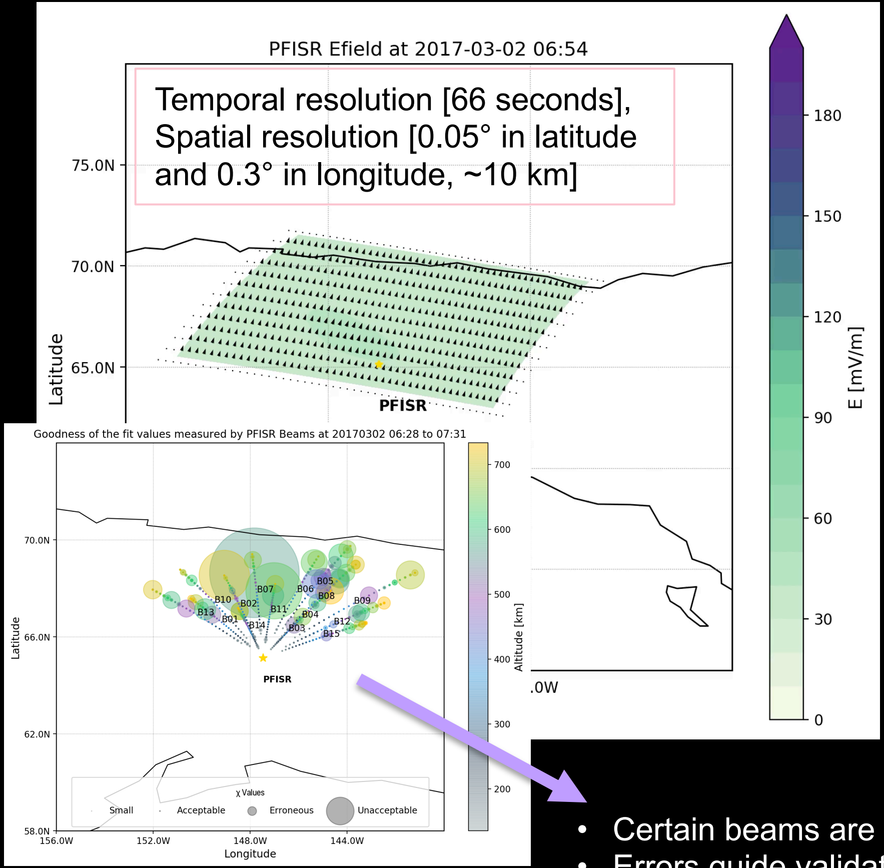
PFISR LOS velocity measurements can be used to derive Electric fields on a 2D grid*.



- Certain beams are more reliable
- Errors guide validation efforts

PFISR aiding the ISINGLASS experiment with 15 beams operating [Clayton et al., 2019, JGR]

→ Calculate and subtract 30 min. average from measurements

$$E_{total} = E_{background} + E_{variability}$$

→ Down sample and calculate the the potential differences in new grid (0.75°x0.75°)

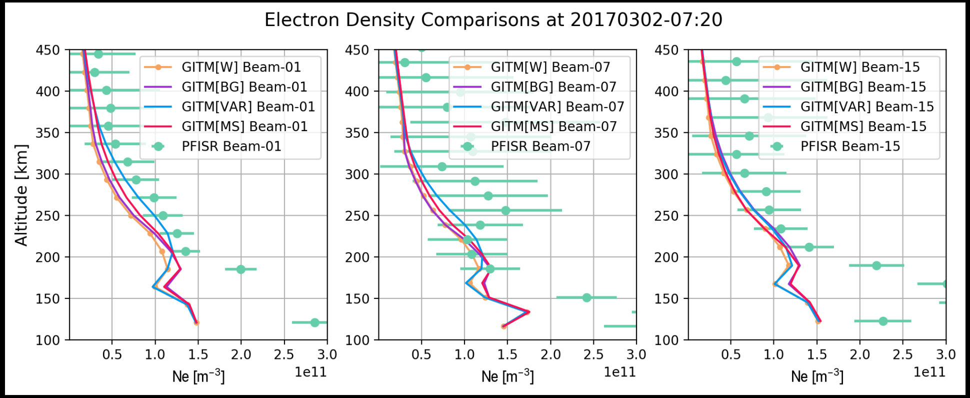
→ Merge the calculated potentials with Weimer potentials to obtain a global potential pattern

→ Drive **GITM**[1] with the new potential patterns

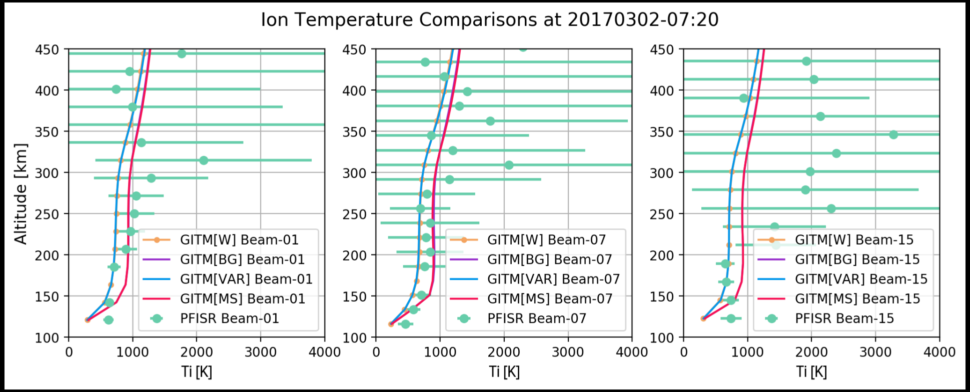
→ Validate results with comparisons of PFISR Ne, Te, and Ti measurements along the beams

* Procedure requires certain amount of beams, data courtesy of Roger Varney and Ashton Reimer.
[1] Ridley, Deng and Toth, JASTP, 2006

Plasma profiles vary for different drivers.



Variability seems to play an important role in electron density above 150 km.



Ion temperature estimates are improved above 200 km, once the background and total electric fields are employed.

Key Points

- We are developing a framework that can utilize **any local (meso-scale) 2D electric field measurement** as input to run a global I-T model.
- Different drivers performed better depending on time and altitude.
- Electron density significantly underestimated below 200 km.

Future work

- Investigate the effects of meso-scale electric fields on the **global energy budget** during active geomagnetic periods.
- Validation Studies: More events, more conjunctions, different sets of measurements
- Error and uncertainty quantification in measurement input and modeling results

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